TIDE
Tidal River Development

Project part-financed by the European Union (European Regional Development Fund)

The Interreg IVB North Sea Region Programme

‘Shallow water area Kleinensieler Plate’

Measure analysis 27
in the framework of the Interreg IVB project TIDE

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NLWKN

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Part 1: Measure description

Measure Category: Biology/Ecology
Estuary: Weser
Salinity zone: oligohaline
Pressure: Habitat loss and degradation
Measure status: implemented
River-km: Weser-km 54 - 55
Country: Germany
Specific location: Lower Saxony, District Wesermarsch, near Rodenkirchen/Stadland
Responsible authority: Water- and Shipping Authority Bremerhaven
Costs: 2.600.000 €
Cost category: 1.000.000 – 5.000.000 €
Picture/Map:

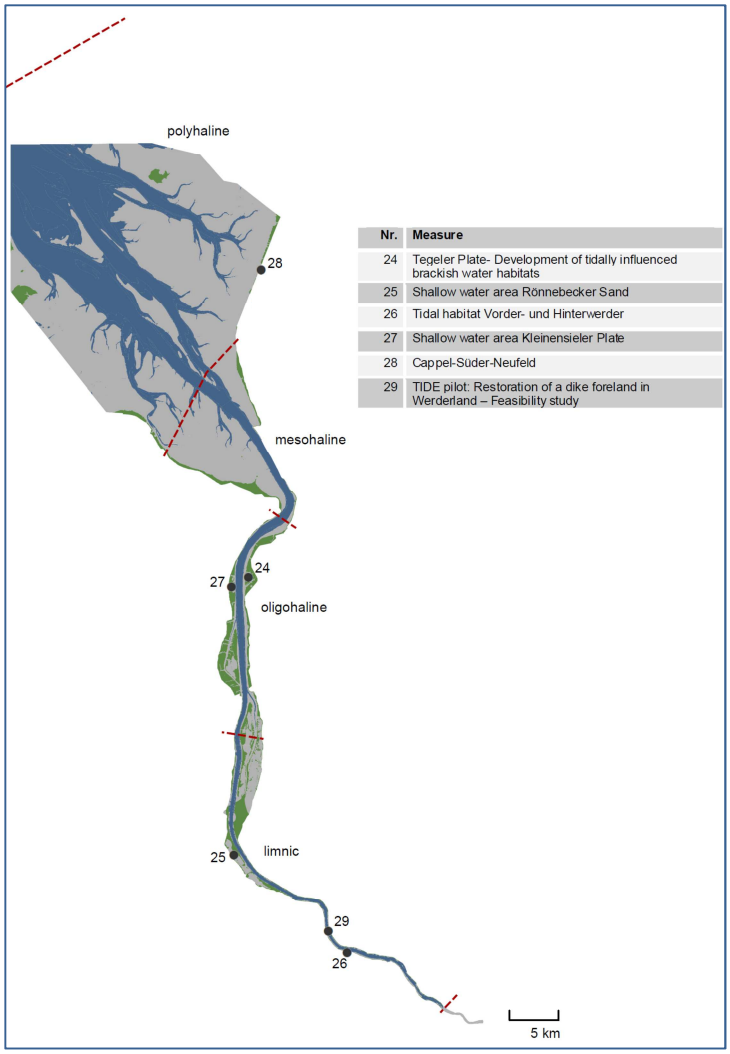

Figure 1: Location of compensation measure 27: ‚Shallow water zone Kleinensieler Plate'

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1.1 Measure description

The measure 'Shallow water zone Kleinensieler Plate' was designed and implemented as a compensation measure after national environmental law for the outer Weser deepening (chart datum -14 m) which was executed in 1998 and 1999.
The project area of the compensation measure is situated at the western shore of the lower Weser River between Nordenham and the ferry terminal Kleinensiel (Figure 2). On a 58 ha former disposal area, a typical habitat succession including tidal waters, reeds, bushes and wide grassland was established.
A 10.5 ha shallow water zone -designed as tidally influenced water permanently covered with water and connected to the river by three overflow barriers- was created. The three overflow barriers were installed 0.5 m below mean high water level and guarantee a minimum water level of 2 m within the shallow water zone. By forming the banks of the shallow water area, the site specific conditions for the settlement of different structured reeds were created. Reed development was left to natural succession.
In order to avoid disturbances, shallow water zone and adjacent reed belt are surrounded by a 39.4 ha extensively used buffer zone.
To ensure surface drainage and as a natural barrier, a new ditch was built. Additionally, several existing ditches were dammed. In order to promote the development of perennial and ruderal meadows and woods, small scale site specific differences were initiated by irregular surface design.
Due to strong siltation tendencies (Figure 3), the shallow water zone was maintained during winter 2004/2005 and the overflow barriers directly connected to the Weser river were heightened.
According to present knowledge, the siltation tendencies were slowed down due to these measures.

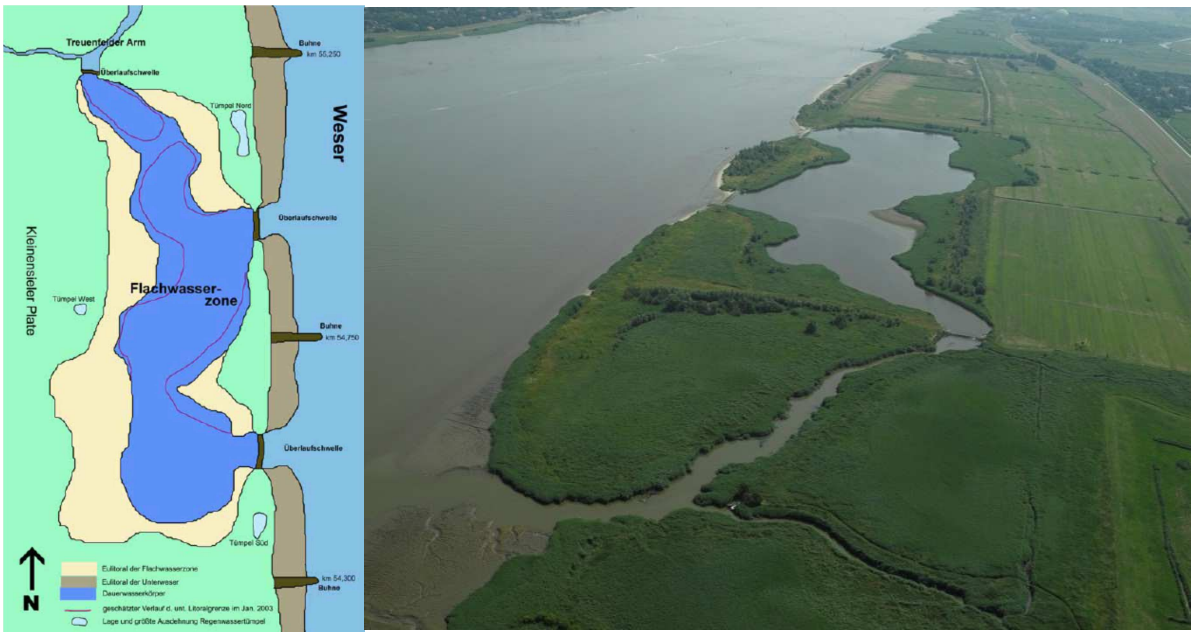

Figure 2, left: Overview on compensation measure ‚Shallow water zone Kleinensieler Plate' according to construction plans of the Water and Shipping Authority Bremerhaven (yellow = eulittoral of shallow water zone, brown = eulittoral of the lower Weser River, dark blue = shallow water zone); source: UNIVERSITÄT BREMEN 2003. Right: Aerial photograph of project area (WSA BREMERHAVEN 2008).

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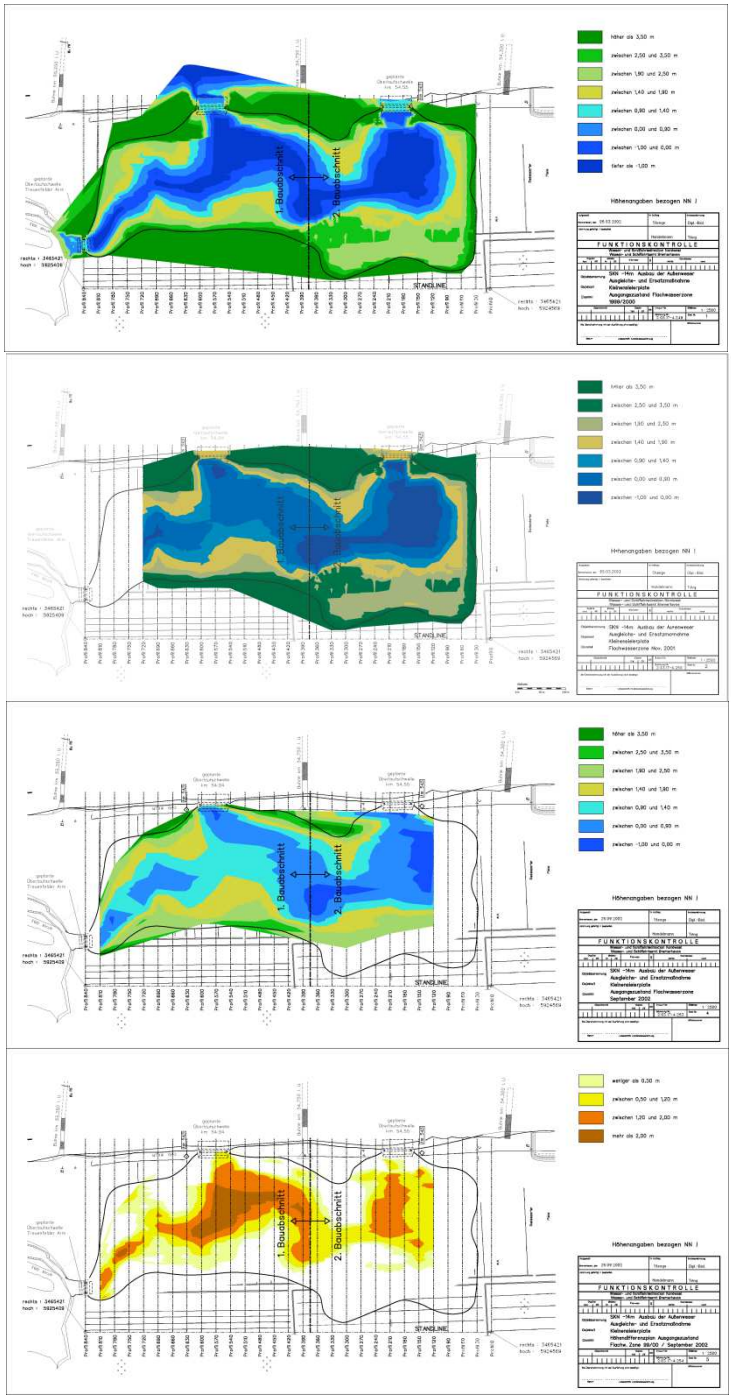

Figure 3: Depth development in the shallow water zone of the Kleinensieler Plate between 1999 and 2002 due to siltation (top charts). The lower chart shows the depth differences which occurred in this period: Brown colour indicates depth differences of more than 2 m; orange colour indicates depth differences between 1.2 and 2 m (source: WSA BREMERHAVEN 2002)

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1.2 Monitoring

The monitoring program was completed in 2010 and included the floowing aspects:

- Aquatic fauna (zooplankton, fish, benthic invertebrate fauna, vagile epifauna)
- Birds
- Vegetation
- Water structures

1.3 Monitoring results

Vegetation

According to KÜFOG 2010, the project area is characterized by diverse vegetation communities which were able to develop because of the different site specific conditions and agricultural use in part areas (Figure 6). Around the tidal polder, typical floodplain vegetation with reeds, ruderal vegetation and wood developed on the areas left to natural succession (Figure 4). In these areas, no maintenance and development measures are currently necessary.

Due to deposition of fine sediments, the tidal polder is affected by siltation. The need for partial dredging could not be investigated in the frame of the vegetation monitoring.

As recommended by MORITZ (2005), mowing of grassland areas should be continued to the benefit of species rich grassland development. Mowing should be favored over grazing.

The growth of grasslands indicates a sufficient amount of nutrients in the ground. The entry of nutrients takes place via episodical flooding. An additional application of fertilizer to the grassland is detrimental. For example, the grassland vegetation adjacent to the dike grew up high due to fertilizer application before the first mowing took place in 2010. This was connected with negative effects on the vegetation stock. In addition, the geographical position of the project area within the river flood plain has to be considered. In case of flood events, fertilizer could get into river.

Figure 4: Shallow water zone with reed and wood (left) and creek adjacent to the overflow barrier in the north of the project area (source: KÜFOG 2010)

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Figure 5: Eroded shore at the Weser with reed community (Phragmitetum australis, left) and ruderal vegetation (Tanaceto-Artemisietum vulgaris, right); source: KÜFOG 2010

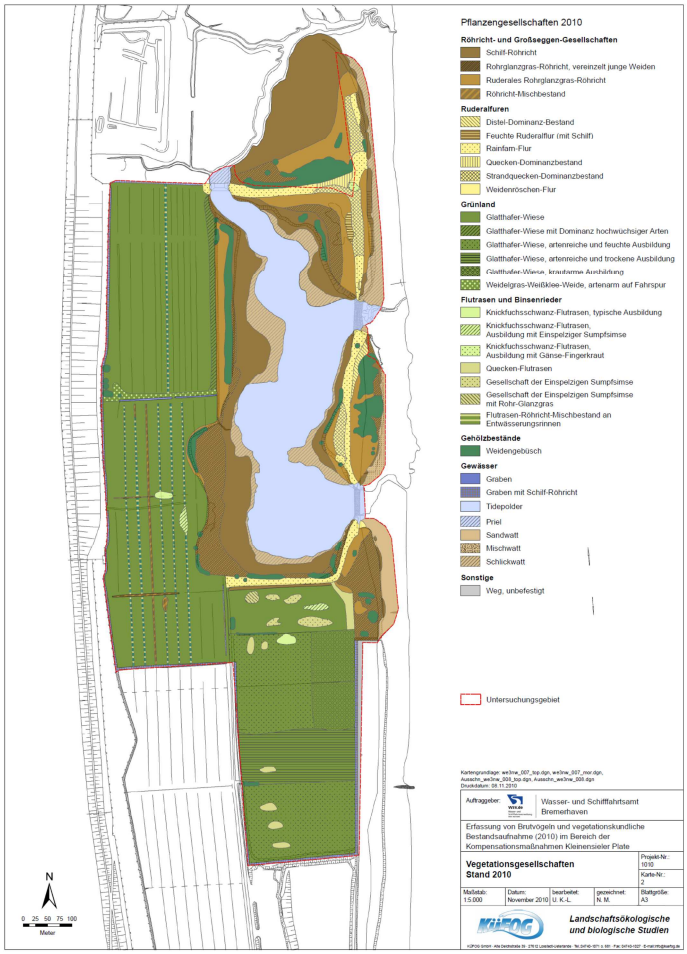

Figure 6: Structure diversity on the project area in 2010 (KÜFOG 2010)

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Birds

Already during the construction phase, water and wading birds like Common snipe (*Gallinago gallinago*), Dunlin (*Calidris alpina),* Common sandpiper (*Actitis hypoleucos*), Pied avocet (*Recurvirostra avosetta)* and Northern lapwing (*Vanellus vanellus*) took over the small waters appearing in the excavation pit. Numerous seagulls, ducks and geese used the new shallow water zone as resting place. The resting and migrant bird populations on the Kleinensieler Plate were considered as important for the federal state of Lower Saxony in terms of Goosander (*Mergus merganser*), Common teal (*Anas crecca*), Eurasian widgeon (*Anas penelope)*, Gadwall (*Anas strepera*), Common gull *(Larus canus canus)* and Smew (*Mergellus albellus*) and as regionally important in view of Common snipe (*Gallinago gallinago*), Graylag goose (Anser anser) and Tufted duck (*Aythya fuligula)*.

According to KÜFOG 2010, the Kleinensieler Plate became less important in view of grassland breeders during the previous years for site specific and supra-regional reasons. The attractiveness of grassland areas before and during breeding time could by increased by creating shallow water areas. In addition, small scale structure diversity could be improved by introducing extensive grazing. Also important is low vegetation at the beginning of breeding time.

In contrast to breeding bird development, wood and reed breeders find suitable habitats in the shore region of the shallow water zone which also attract demanding and endangered species. Due to the occurrence of numerous breeding pairs of endangered species, the project area represents a breeding bird site of importance for the federal state of Lower Saxony (MORITZ 2005).

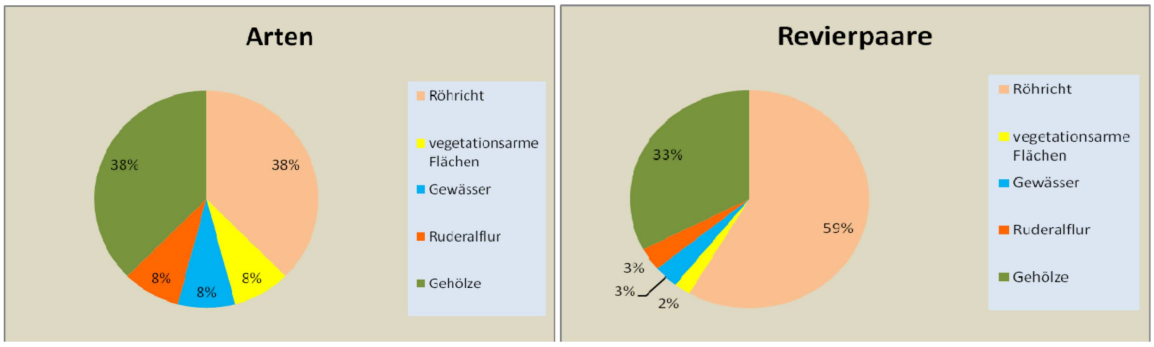

Figure 7: Percentages of breeding bird guilds on the compensation area of the Kleinensieler Plate in terms of species ('Arten', left) and breeding pairs ('Revierpaare'). Especially reed breeders find suitable habitats in the shore region of the shallow water zone (see 'Röhricht'), source: KÜFOG 2010

During the last years, the attractiveness of shallow water areas and silted up mud areas for migratory birds increased. Different coastal birds used these areas for resting and feeding purposes.

Aquatic fauna

After measure implementation, the waters were immediately settled by numerous animal species of the brackish water zone. The shallow water zone is of special importance for zooplankton, vagile epifauna (e.g. opossum shrimps (Mysida) and juvenile migratory fish (flounders, gobies). The settlement of the water bed was less pronounced. Probably, the suspended matter entering the project area is too soft to be settled (UNIVERSITÄT BREMEN 2003).

After maintaining the shallow water zone and heightening two overflow barriers in 2005, the entry of suspended matter decreased significantly and sediments stabilized. Thus, the population densities in sediment developed positively. The importance of the shallow water zone for zooplankton and vagile epifauna could be confirmed.

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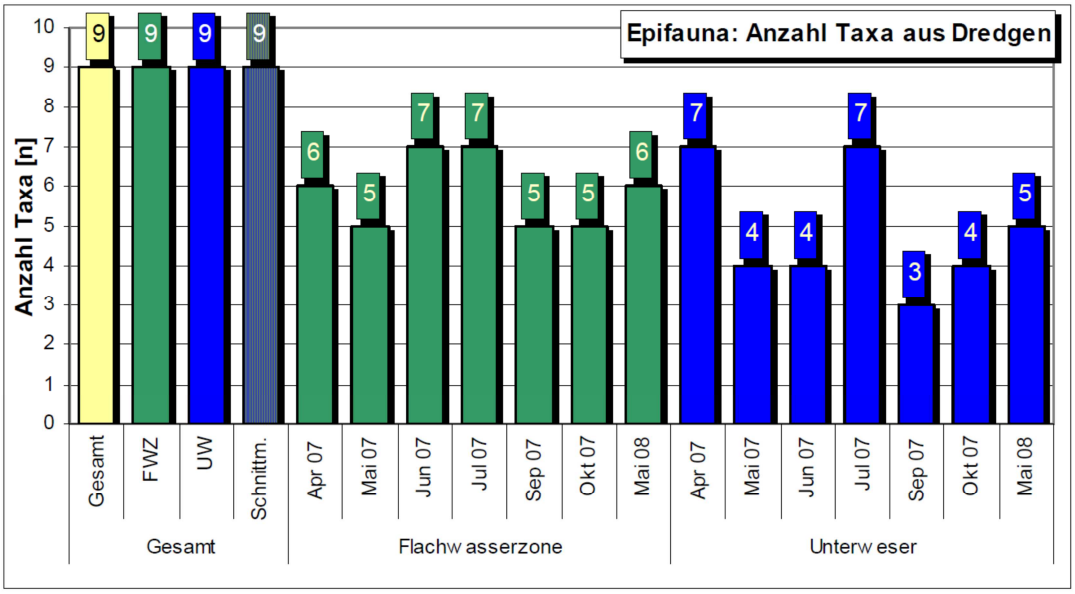

Figure 8: Number of epifauna taxa found in dredge samples in 2007/2008 comparing shallow water zone of the Kleinensieler Plate ('Flachwasserzone', FWZ) and adjacent lower Weser River ('Unterweser', UW) and their seasonal development. Intersection ('Schnittmenge'): Number of species found in shallow water zone and in lower Weser River (source: LANGE, DROSTE, MEYERDIRKS 2008).

Compared to juvenile flounders of the lower Weser, juvenile flounders using the shallow water zone as feeding ground showed significantly better filled stomachs. This finding points out the special importance of shallow water zones for the nutrition of flounders (Figure 9).

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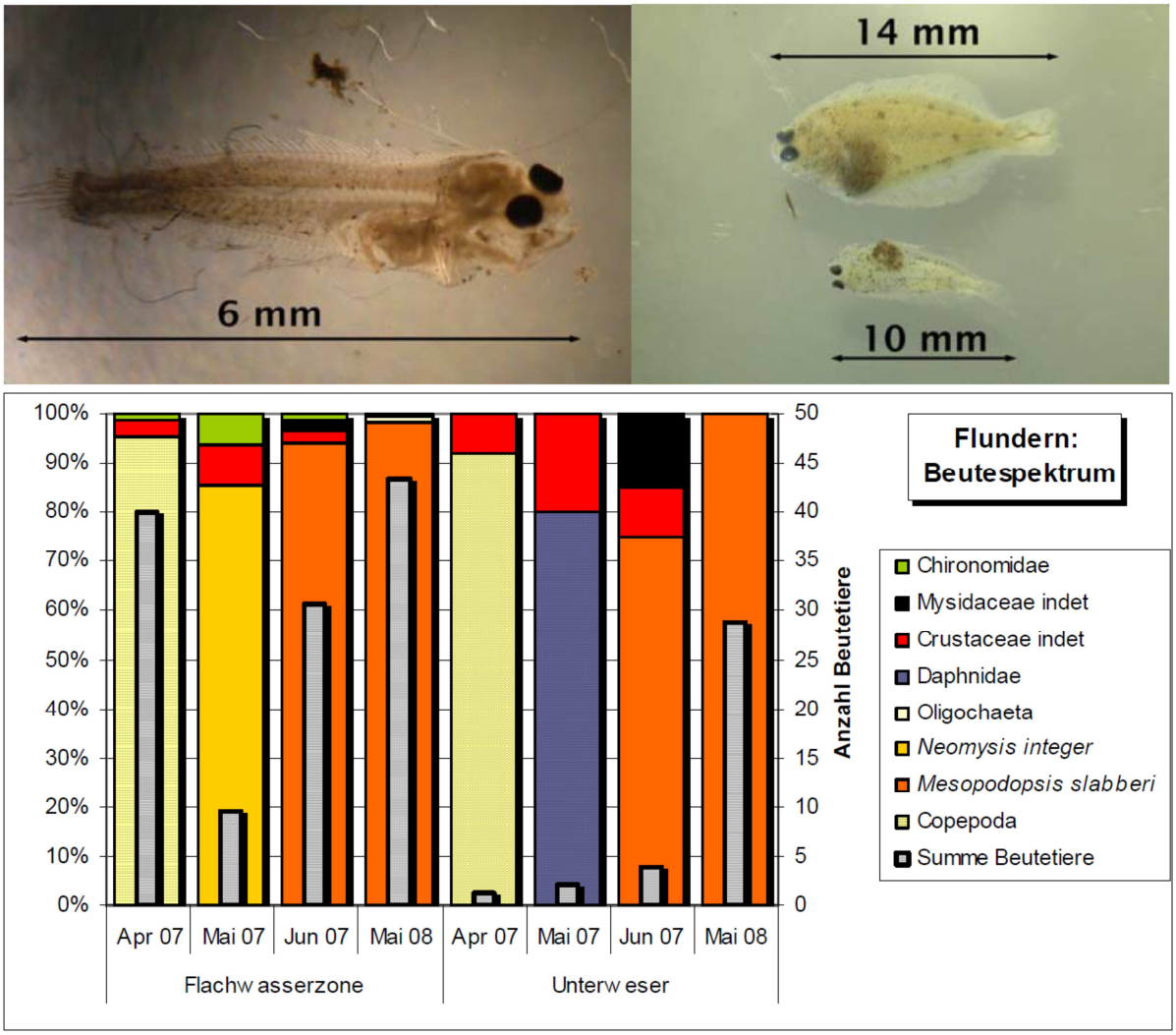

Figure 9, above: Flounder larvae found in the shallow water zone: 6 mm larvae with starting body rotation, 10 and 14 mm individuals with filled digestive tract. All individuals were found in dredge samples in April 2007; below: Number (grey bars) and composition (coloured bars) of prey in digestive tracts of flounders found in shallow water zone of the Kleinensieler Plate ('Flachwasserzone') and the lower Weser River ('Unterweser'); source: LANGE, DROSTE, MEYERDIRKS 2008.

Part 2: Execution of main effectiveness criteria

2.1 Effectiveness according to development targets of measure

-Step 1: Definition of development targets

- Development of specific estuarine, tidally influenced processes
- Availability of shallow water habitats for aquatic fauna, especially in the oligohaline zone of the Weser River
- Development of reed and wet grassland habitats

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-Step 2: Degree of target achievement

Although the tidal influence is restricted by three overflow barriers, the project area is regularly influenced by the tides and the appearance of several specific vegetation and fauna features of the brackish water zone of the Weser was confirmed by the monitoring results. Due to heightening two overflow barriers, the amount of suspended matter entering the project could be reduced. This means that –to the benefit of vegetation, fauna and water structures- les maintenance effort can be expected in the future. The degree of target achievement can be considered as high.

2.2 Impact on ecosystem services

The measure 'Shallow water area Kleinensieler Plate' in the freshwater zone of the Weser estuary was about the creation of estuarine habitats by transforming adjacent land into marshland as well as subtidal shallow habitat and intertidal steep habitat connected with a high change in the habitat quality (Figure 10). From the ecosystem services (ES) assessment, it is concluded that this measure generates overall a positive expected impact for many ES, mainly for 'biodiversity' and different regulating services (erosion and sedimentation regulation by water bodies, water quality regulation: reduction of excess loads coming from the catchment. The expected impact on the development target 'biodiversity' is very positive. The expected impact for the different beneficiary groups is overall positive, with a positive to very positive expected impact for indirect and future use and for local use (Table 1).

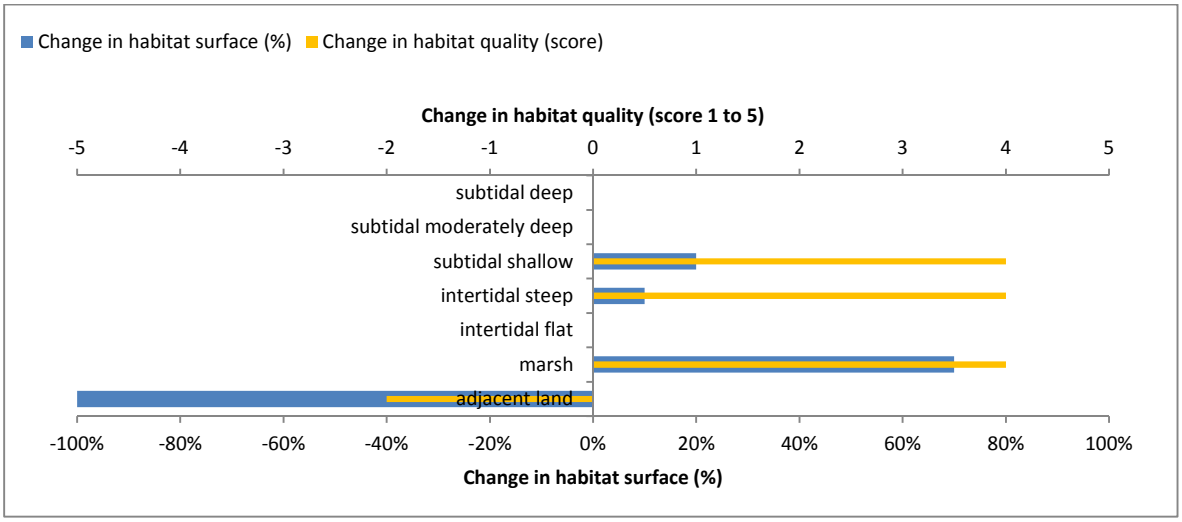

Figure 10: Ecosystem services analysis for measure ‚Shallow water area Kleinensieler Plate': Indication of habitat surface and quality change, i.e. situation before versus after measure implementation.

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Table 1: Ecosystem services analyis for measure ‚Shallow water area Kleinensieler Plate': (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure

Shallow water area Kleinensieler Plate

Cat.	Ecosystem Service	Score
S	"Biodiversity"	3
R1	Erosion and sedimentation regulation by water bodies	3
R2	Water quality regulation: reduction of excess loads coming from the catchment	3
R3	Water quality regulation: transport of polutants and excess nutrients	0
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	2
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	2
R8	Climate regulation: Carbon sequestration and burial	2
R9	Water quantity regulation: dissipation of tidal and river energy	0
R10	Regulation extreme events or disturbance: Wave reduction	1
R11	Regulation extreme events or disturbance: Water current reduction	1
R12	Regulation extreme events or disturbance: Flood water storage	2
P1	Water for industrial use	0
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	2
C2	Inspiration for culture, art and design	2
C3	Information for cognitive development	2
C4	Opportunities for recreation & tourism	2

Beneficiaries:	
Direct users	0
Indirect users	2
Future users	3
Local users	2
Regional users	1
Global users	1

X Targeted ES

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

2.3 Degree of synergistic effects and conflicts according to uses

The material excavated from the shallow water zone is supposed to be used or was used already for main dike and bank reinforcement purposes. Thus, synergistic effects in view of coastal defense and flood protection can be stated. Additionally, an 850 m shore section north of the ferry terminal Kleinensiel is fully usable as beach again after parts of the excavated material were spread. Here, no conflicts with tourism, leisure and local recreation appeared.
In terms of the development of grassland breeders and migratory birds, disturbances caused by walkers with free running dogs represent a severe problem. There is a need for concepts to guide visitors through or along the project area.

Part 3: Additional evaluation criteria in view of EU environmental law

3.1 Degree of synergistic effects and conflicts according to WFD aims

The compensation measure 'Shallow water zone Kleinensieler Plate' was not designed to meet the requirements of the Water Framework Directive (WFD). However, it covers five of six pressures the oligohaline zone of the river Weser is affected by (Table 2).

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Table 2: Measure effects on main pressures of the oligohaline zone of the Weser estuary

Indi-cator	Code	Main pressures **oligohaline** zone Weser	Effect?					Description
			- -	-	0	+	++	
S.I.	-	Habitat loss and degradation during the last 100 years: Subtidal					X	Additional subtidal areas (e.g. shallow water zone) were created.
S.I.	1.1	Habitat loss and degradation during the last 100 years: Intertidal					X	Additional intertidal areas were created (e.g. tidal mudflats).
S.I.	1.4/ 1.5	Gross change in morphology/hydrographic regime during the last about 100 years				X		The measure recreated habitats which got lost on a large scale due to river straightening and deepening measures in the past. Therefore, the measure contributes to mitigating the negative consequences of the gross changes in morphology and hydrographic regime which took place during the last 100 years.
D.I.	1.3	Land claim during the last about 100 years					X	Land was given back to the river; the tidal influence on the project area was increased.
D.I.	2.6	Capital dredging			X			There are no direct effects to be stated, but measure generally contributes to mitigating the negative effects of capital dredging.
D.I.	2.4	Maintenance dredging				X		By trend, the measure implementation leads to less maintenance effort in the river Weser due to additional sedimentation area on the Kleinensieler Plate.

S.I. = state indicator;
D.I. = driver indicator

3.2 Degree of synergistic effects according to Natura 2000 aims

The Kleinensieler Plate is located in a Special Protection Area (SPA) after the Habitat Directive (Site name: Unterweser; site code: DE 2316-331). According to the Integrated Management Plan Weser (IBP Weser), the Kleinensieler Plate is assigned to operational area 2. Although the compensation measure was not designed to meet the requirements of Natura 2000, potential positive effects on several conservation objectives defined for operational area 2 (Table 3) and for the entire investigation area of the IBP Weser (Table 4) can be stated.

-Step 1: Estimate potential measure effects on conservation objectives for certain spatial units

Table 3: Natura 2000-objectives with specifications for operational area 2 (source: simplified after NLWKN, SUBV 2012)

Operational area 2: Oligohaline zone in the lower Weser (Weser-km 40 - 65)				
Specifications for operational area 2	**Effect of measure 27 on conservation objectives?**			**Short explanation**
	positive effect	no effect	negative effect	
Conservation and development of specific estuarine habitats and (tidal) floodplains and their dynamic changes				
Development, enlargement and upgrade of shallow water zones with moderate current climate	++			A shallow water zone with reduced tidal range was created.
Development of passable shore structures	+			The project area is connected to the river by three overflow barriers temporarily passable for organisms.

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Conservation and development of typical habitats of operational area 2 (e.g. mudflats, reeds, extensively used and salt-influenced grasslands, tidal floodplains) in a dimension, spatial distribution and interconnection ensuring long-term appearance of typical species	++			Typical habitats like mudflats and reeds were developed.
Conservation and development of habitats for viable populations and estuary and (tidal) floodplain specific species as well as species after Annex II Habitats Directive and bird species after Birds Directive				
Conservation and development of undisturbed resting and moulting areas for migratory bird populations (high diversity, many individuals) considering all necessary functions	+			According to KÜFOG 2010, the Kleinensieler Plate became increasingly attractive in view of migratory birds during the last years. This especially refers to shallow water areas and silted up mud areas. Various birds of the coast use these areas for resting and feeding purposes.
Conservation of typical breeding bird communities and associated habitats (breeding birds of extensively used, salt-influenced grasslands and reeds)	+			According to KÜFOG 2010, the Kleinensieler Plate provides attractive breeding habitats for reed and wood breeders. Due to occurrences of many endangered species, the project area is labeled as breeding site of importance for Lower Saxony. By comparison, the Kleinensieler Plate became less attractive for grassland breeders during the last years. The attractiveness before and during breeding time could be increased by creating shallow water areas on grassland areas and by introducing extensive agricultural use (structure diversity, low vegetation).
Preservation and development of nursery ground function for Twaite shad (e.g. preferential water quality for juveniles and larvae)		0		Shallow water zone does not provide suitable spawning grounds for Twaite shad.
Preservation and development of undisturbed resting and moulding areas for Pied avocet	+			Shallow water zones and silted up mud serve as feeding and resting grounds for Pied avocet (KÜFOG 2010).
Conservation and development of well-structured bordering waters and shore areas with wood, typical shore vegetation and reeds as hunting and feeding ground for Pond bat (*Myotis dasycneme*) (e.g. creek systems on Tegeler Plate, on Einswarder Plate, shallow water zone Kleinensieler Plate….),	+			A permanent water area with natural shore vegetation was created and potential prey for Pont bat (e.g. Chironomidae) was found in the shallow water zone.
Conservation of site specific requirements and area percentages of aquatic structures as habitats for typical benthic invertebrate fauna	+			Development of zooplankton populations in shallow water zone mostly independent from populations of lower Weser River; recently high abundances of endobenthos communities; shallow water zone functions as feeding, nursery and reproduction ground (LANGE, DROSTE, MEYERDIRKS 2008)
Conservation and development of favorable conditions on estuary grassland in order to promote long term establishment of Bulbous foxtail		0		Not investigated.
Conservation of wide, salt-influenced reeds representing habitats for specialized invertebrate fauna (e.g. typical Auchenorrhyncha species)		0		Not investigated, but newly developed reed potentially represents suitable habitat.

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-Step 2: Estimate potential measure effects on overall conservation objectives

Table 4: Natura 2000-objectives with specifications for entire investigation area of the Integrated Management Plan Weser (IBP Weser); source: simplified after NLWKN, SUBV 2012

Specifications for entire investigation area of IBP Weser	Effect of measure 27 on conservation objectives?		
	positive effect	no effect	negative effect
Conservation and development of specific functions and processes of estuaries and (tidal) floodplains to reach favourable abiotic conditions and typical hydromorphological structures			
Conservation and development of favourable water structures and water bed dynamics	++		
Development of evenly distributed and reduced current energy and tidal parameters	++		
Conservation and development of favourable gradients of specific aspects regarding estuaries and (tidal) floodplains (e.g. salinity, sediments, current conditions, tidal range, close-to-nature zonation of shore vegetation…); refers to inner estuary and to area between estuary and floodplain within fresh water zone.	+		
Improvement of water and sediment quality	+		
Conservation and development of specific estuarine habitats and (tidal) floodplains and their dynamic changes			
Conservation and development of habitats and communities which strongly depend on the natural dynamics of morphological processes (e.g. mudflats, shallow waters, creeks…)	+		
Development of balanced area percentages regarding mudflats, shallow waters, shallow and deep sublitoral	+		
Conservation and development of tidal floodplains with typical vegetation structures and biocoenosis and favourable tidal and flooding dynamics; especially floodplain enlargement	+		
Conservation and development of habitats for viable populations and estuary and (tidal) floodplain specific species as well as species of Annex II Habitats Directive and bird species of Birds Directive			
Conservation of habitat functions for breeding and migrant birds especially as feeding grounds (also for bordering or networked areas)	+		
Conservation and development of habitat requirements for migratory fish stocks and cyclostomata within present territories and networked areas	+		
Conservation and development of habitat requirements for autochthon fish communities with typical age composition and typical percentage of estuarine species and diadromous migratory fish species	+		
Conservation and development of long-term viable populations of typical fish species and cyclostomata (estuarine and diadromous guilds)	+		
Reaching of favourable water quality for reproduction, larval development and viability of typical fish communities of different salinity zones	+		

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Conservation and development / reestablishment of passability of the tidal river Weser and its tributaries for migratory fish and benthic invertebrates		0	

Part 4: Crux of the matter

Before heightening the overflow barriers in 2005, the shallow water zone on the Kleinensieler Plate was strongly affected by siltation (Figure 3). As a result of heightening two of the overflow barriers, the amount of suspended matter entering the project area was reduced significantly and siltation tendencies were slowed down. At the same time, the tidal influence on the project area was restricted. To optimize the interplay of highest possible tidal influence and tolerable suspended matter entry (= tolerable maintenance effort) should be a key issue in view of future planning and implementation processes of comparable measures. It should also be considered whether the design of the overflow barriers can be used to initiate some flowing dynamic in the shallow water zone in order to prevent too high sedimentation rates. This was the goal in keeping the barrier to Treuenfelder Arm on the original level, now some 30 cm lower than the heightened ones to river Weser. However, there will be no way to completely avoid siltation without creating a different habitat with differing features and functions.

Part 5: Literature

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